Antineutrino Detector for Reactor Monitoring and looking for sterile neutrinos

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The low-background antineutrino detector DANSS (Detector of Anti-Neutrino based on Solid Scintillator) designed for remote nuclear reactor monitoring is presented here [1].

The detector is made from polystyrene strips configurated in layers with orthogonal directions. They fixed in cooper corps which plays a role of passive shielding. The construction of 5 modules containing 2500 strips in total placed in passive and active shielding will be installed at the hall of reactor building at close distance from the core. The distance can be varied between 10 and 13 m with a help of special device (lift). The final installation of the detector is planning in 2014 at Kalinin Power Plant (Russia, Udomlya).

Variable distance will be used for testing the reactor antineutrino anomaly and looking for sterile neutrinos. Counting rate of useful events $\sim$10000 per day.

The antineutrino spectrometer will be about 1 m^3 plastic-scintillator detector divided into 2500 strips surrounded by a multilayer passive shielding of copper (5 cm), lead (10 cm), and borated polyethylene (8 cm) for suppression of the external radiation and neutron background. Estimated DANSS efficiency is $\sim$70%. To discriminate the cosmic ray background, active shielding comprising consisting of 6 planes of scintillation counters $150\times150\times3$ cm^3 in size surrounds the passive shielding.

The main (basic) element of the spectrometer is the *scintillation strip*. Strip dimensions are $4\times1\times100$ cm^3.

The basic structural element of the detector is a section. Ten X and Y ten layers combined together make up a section $-$ a layered structure $100\times100\times20$ cm^3 in size fixed to a copper frame which simultaneously serves as the inner part of the passive shielding. Each section can be independently mounted, adjusted, and transported to the final assembly site (Kalinin NPP, Udomlya). Five sections assembled together and surrounded by the additional passive and active shielding form the full spectrometer. Due to its section structure, it is possible to start testing the device with $1-2$ sections (when the other are not made yet) and to increase the volume of the detector, if necessary, by adding extra sections.

Last time the interest to sterile neutrinos is growing from day to day. Firstly they published data from LSND experiment where the excess of electron neutrinos was observed. Later results of MiniBOONE experiment did not resolve this hint. Then the results of SAGE and GALLEX calibration experiments have shown the deficit of observed events what could be interpreted as presence of fourth neutrino state with large Δm^2 parameter. And finally, the calculated antneutrino energy spectrum, accounted by authors as most accurate, applying to previous reactor experiments demonstrated so called "reactor antineutrino anomaly" [2] $-$ the deficit of neutrino events in reactor experiments. Some time ago joint analysis of reactor experiments also demonstrated probable parameters contours for unusual oscillations [3]. To test these anomalies one precise experiment is needed. We suppose to use the developed in our collaboration detector DANSS for looking for neutrino oscillations in sterile mode. Fortunately available halls allow to place the detector at convient distances from the reactor core. Constraints on oscillation parameters for steriles are shown at fig. 1.

In DANSS collaboration the prototype of the detector was made and installed at Kalinin Power Plant. They used a fashion of 100 strips placed in passive and active shielding close to the reactor core. Total detector volume is 20x20x104 cm^3 (40 l). The distance to reactor core is 12 m. Overburden of the place is 60 m.w.e. The detector sees about 110 neutrino events per day with $\sim$20% level of background (in DANSS it will be smaller). Detection efficiency of DANSSino is estimated as 20%.

We expect to start data tacking with full scale detector in 2014.

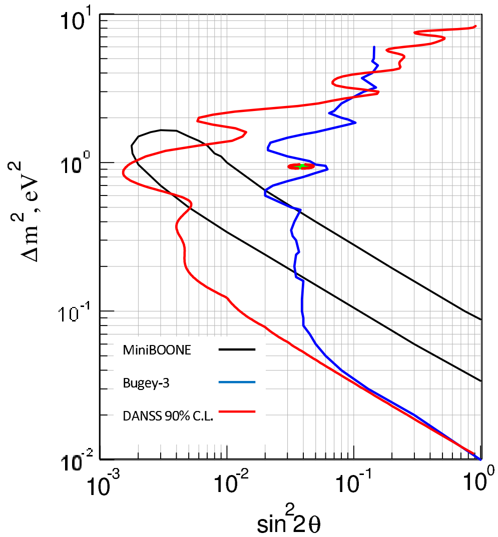

FIG. 1: Limitations on oscillation parameters in case of evidence absence and region for possible parameters in case of founding the evidence of oscillation (red line). MiniBOONE (black) and Bugey-3 (blue) curves are shown also.

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